Estuary Live 2003

South Slough Estuarine Research Reserve

Middle Level Curriculum Guide

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Middle Level (grades 4-8)

Moon Observation Project

Subject Areas
Earth Science, Fine Arts (sketching)

Objectives
Students will understand :
1. the relationship of the earth's motion to the day, year, and phases of the moon.

Materials
Light source (light bulb)

Globe

Tennis ball

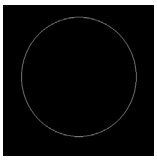
Observation record sheets

Duration
Introduction - 40 minutes
Observations - 15 minutes each day

Overview
Students will observe the phases of the moon of the course of one month.

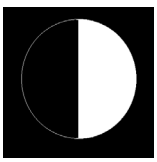
Background Information

From any location on the Earth, the Moon appears to be a circular disk which, at any specific time, is illuminated to some degree by direct sunlight. Like the Earth, the Moon is a sphere which is always half illuminated by the Sun, but as the Moon orbits the Earth we get to see more or less of the illuminated half. During each lunar orbit (a lunar month), we see the Moon's appearance change from not visibly illuminated through partially illuminated to fully illuminated, then back through partially illuminated to not illuminated again. Although this cycle is a continuous process, there are eight distinct, traditionally recognized stages, called phases. These phases of the Moon, in the sequence of their occurrence (starting from New Moon), are listed below.

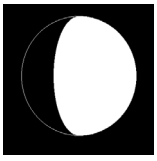


New Moon - The Moon's unilluminated side is facing the Earth. The Moon is not visible (except during a solar eclipse).

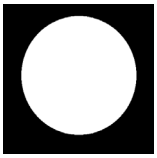
Waxing Crescent - The Moon appears to be partly but less than one-half illuminated by direct sunlight. The fraction of the Moon's disk that is illuminated is increasing. Appears low in the evening sky just after sunset.



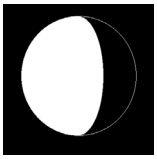
First Quarter - One-half of the Moon appears to be illuminated by direct sunlight. The fraction of the Moon's disk that is illuminated is increasing.



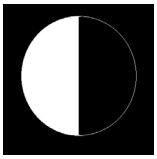
Waxing Gibbous - The Moon appears to be more than one-half but not fully illuminated by direct sunlight. The fraction of the Moon's disk that is illuminated is increasing.



Full Moon - The Moon's illuminated side is facing the Earth. The Moon appears to be completely illuminated by direct sunlight.



Waning Gibbous - The Moon appears to be more than one-half but not fully illuminated by direct sunlight. The fraction of the Moon's disk that is illuminated is decreasing.



Last Quarter - One-half of the Moon appears to be illuminated by direct sunlight. The fraction of the Moon's disk that is illuminated is decreasing.

Waning Crescent - The Moon appears to be partly but less than one-half illuminated by direct sunlight. The fraction of the Moon's disk that is illuminated is decreasing.

Following waning crescent is New Moon, beginning a repetition of the complete phase cycle of 29.5 days average duration.

Because the cycle of the phases is shorter than most calendar months, the phase of the Moon at the very beginning of the month usually repeats at the very end of the month. When there are two Full Moons in a month (which occurs, on average, every 2.7 years), the second one is called a "Blue Moon".

Although Full Moon occurs each month at a specific date and time, the Moon's disk may appear to be full for several nights in a row if it is clear. This is because the percentage of the Moon's disk that appears illuminated changes very slowly around the time of Full Moon (also around New Moon, but the Moon is not visible at all then). The Moon may appear 100% illuminated only on the night closest to the time of exact Full Moon, but on the night before and night after will appear 97-99% illuminated; most people would not notice the difference. Even two days from Full Moon the Moon's disk is 93-97% illuminated.

New Moon, First Quarter, Full Moon, and Last Quarter phases are considered to be primary phases and their dates and times are published in almanacs and on calendars. The two crescent and two gibbous phases are intermediate phases, each of which lasts for about a week between the primary phases, during which time the exact fraction of the Moon's disk that is illuminated gradually changes.

The phases of the Moon are related to (actually, caused by) the relative

positions of the Moon and Sun in the sky. For example, New Moon occurs when the Sun and Moon are quite close together in the sky. Full Moon occurs when the Sun and Moon are at nearly opposite positions in the sky - which is why a Full Moon rises about the time of sunset, and sets about the time of sunrise, for most places on Earth. First and Last Quarters occur when the Sun and Moon are about 90 degrees apart in the sky. In fact, the two "half Moon" phases are called First Quarter and Last Quarter because they occur when the Moon is, respectively, one- and three-quarters of the way around the sky (i.e., along its orbit) from New Moon.

Procedure

1. Provide a demonstration of the phases of the moon using a light source, a globe, and a ball.
2. Introduce the moon observation project. Explain to students that for the next month, they will make observations of the moon each day and record their observations on their record sheets or journal.
3. The daily sheets can be used to record your daily observations. Be sure to include the following information:

    - Time: When did you see the moon. If you could not see the moon on a particular day, record the times that you tried to find the moon.
    - Phase: Record the phase of the moon in two ways. First, color in the shape of the visible or lit-up part of the moon. Second, write the name of the phase in the space for observations.
    - Direction and Position: Is the moon in the north, south, east, or west? Is it low near the horizon, medium, or high overhead?
    - Sky Conditions: Describe the sky conditions as clear, partly cloudy, or cloudy. This may be a very important observation and help to explain why you couldn't see the moon.

Assessment

Students should be able to successfully complete the observation record sheets provided.

Name ______________________________ Date ______________________

Moon Observations

Directions: Complete one sheet for each week. Record as much information as possible. If the moon is not visible, be certain to record the time of day and sky condition. The circle on the right hand side is to be used to help you sketch the moon as it appears to you.

	Date: ____________ Time of Day: __________ Name of Moon Phase: ____________________ Condition of Sky:	Location in Sky: N W E S
	Date: ____________ Time of Day: __________ Name of Moon Phase: ____________________ Condition of Sky:	Location in Sky: N W E S
	Date: ____________ Time of Day: __________ Name of Moon Phase: ____________________ Condition of Sky:	Location in Sky: N W E S
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The Tides

Subject Areas
Earth Science, Mathematics (Graphing)

Objectives
Students will understand that:
1. Twice each day the seashore is covered with seawater or exposed to air.
2. Tides are caused by the gravitational pull of the sun and moon on the earth's ocean, and the spinning motion of the earth's rotation.
3. Tides are predictable.

Materials
Tide chart for Sept. 2003 from www.southsloughestuary.org

Transparency of tide diagrams

Tide graph

Duration
60 minutes

Overview
Students will utilize a tide chart to graph the tidal highs and lows for the month of September. Utilizing this chart, students will make observations of how the moon phases affected the tidal heights.

Background Information

The oceans are huge bodies of water that cover almost ¾ of the earth's surface. The oceans, as large as they may be, are affected by the physical forces of **gravitation** and **centrifugal force**.

The moon's gravitational force does not have a noticeable effect on the solid parts of the earth. But the oceans are liquid, and the moon's gravitation is strong enough to pull the surface of the ocean into a huge bulge called a **tidal bulge**. On the opposite side of the earth from the moon is a second tidal bulge resulting from the centrifugal force of the earth's motion.

When a tidal bulge is located in the middle of the ocean, it is difficult to detect. But as the earth rotates, a land mass passes through a bulge and the bulge can be detected. Land masses of the earth rotate through these bulges because the earth makes one complete rotation on its axis every 24 hours. We detect the bulges as rhythmic, local changes in sea level which are known as **tides**. Figure 1 shows the relative positions of the earth and moon during a high tide.

The rotation of the earth causes the Oregon coast to be affected by two tidal bulges every 24 hours and 50 minutes. When the coast is located in the middle of a bulge, it is **high tide**. When the coast is located in the area between two tidal bulges, it is **low tide**. The average difference in height between high and low tides is the **mean tidal range**. At Coos Bay the mean tidal range is about 1.7 meters (5.6 feet).

Since the Oregon coast rotates through the two bulges every 24 hours and 50 minutes, there are two high tides and two low tides every 24 hours and 50 minutes. The changes in tide level which occur during that period are called a **tidal cycle**.

The height of the tides is influenced by many secondary factors. Some influences - for example, the extremely high tides that occur during major storms – affect the tides for only a few hours. Other influences

are due to secondary factors that are essentially permanent. Three such factors modifying tide heights are the effect of the sun's gravitational force, the shape of the ocean basin, and the shape of the coastline in the area where the tide is measured. The shapes of the ocean basin and coastline are important because in some areas they amplify the height of the bulges, resulting in a daily average sea level difference in excess of 13 meters (42.9 feet).

When the moon is new or full, the sun and moon form a straight line with the earth. At those times the gravitational forces of the moon and sun combine to make one of the bulges larger, and thus the height difference between high and low tides is greater than the average tide height. **Spring tides** describe the tides that occur at new or full moons. Spring tides in Coos Bay may have an average tide level difference of 2.2 meters (7.4 feet) or more. Figure 2 shows the relative positions of the earth, sun, and moon during spring tides.

When the moon is in an intermediate state – that is, when it is in its first or third quarter – the moon and the sun are 90° from each other. Because the gravitational forces of the sun and moon are not in line with each other, the sun's gravitational force reduces the height of the tidal bulges. Thus, the height difference between high and low tides during the quarter moons is smaller than the average tide height. These tides are called **neap tides**. Figure 2 shows the relative positions of the earth, sun, and moon during neap tides.

The moon circles the earth once every 27.5 days. During this time the sun and moon are aligned with each other twice and are 90° to each other twice. This causes two sets of neap tides and two sets of spring tides every 27.5 days.

The tides responsible for the movement of ocean water into and out of the estuary. Twice each day millions of liters of ocean water flood into the estuary and mix with the freshwater from the river and streams. The flooding tide brings salt water, sediment, ocean animals, plankton, and nutrients with it. Twice each day millions of liters of diluted ocean water ebb out of the estuary and into the ocean. The ebbing tide carries estuarine animals and plankton, ocean animals and plankton, nutrients, sediment, and materials carried in by the river. Of course, any pollutants entering the river, the ocean, or the estuary are also carried by the flooding and ebbing tides.

Procedure

1. Create a transparency of figures 1 and 2.

2. Lead a discussion of how the sun and moon combine forces to cause the tides.

   Using Figure 1
   - What creates a bulge in the ocean at point A? (The gravitational pull of the moon and to a lesser extent the sun.)
   - What causes the second bulge to occur at point B? (The centrifugal force of rotation.)
   - What causes the tides to rise and fall? (The rotation of the earth and moon.)
   - Where does the water go at low tide? (It is pulled away from the shoreline by the gravitational pull of the moon.)

   Using Figure 2
   - Which has a greater pull on the ocean, the moon or the sun? (The moon.) Why? (It's closer to the earth.)
   - What causes spring tides or the highest tides of the year? (The combined forces of the sun and the moon.)
   - What causes neap tides or less than average tides? (The gravitational forces of the sun and the moon working against each other because they are at right angles.)
   - How often does the tide rise and fall during a day on the Oregon coast? (Two high tides and two low tides each day.)

3. Pass out the tide books (or copies of the Sept 2003 page).

4. Ask students to graph the tidal heights for the month.

5. Ask students to compare the tide graph with their moon observations. Show on the graph the dates on which each major moon phase occurs.

Assessment

In addition to graphing the tides, students should be able to successfully answer the activity questions provided on the following page.

Modifications

Students can be paired according to ability to assure success in the graphing.

Name: _____ Date: _____

The Tides

Activity Review Questions

1. How is a.m. written differently from p.m. in the tide book?

2. How many high tides, and how many low tides does the Oregon coast have each day?

3. List the time and tide level for all tides on this date _____.

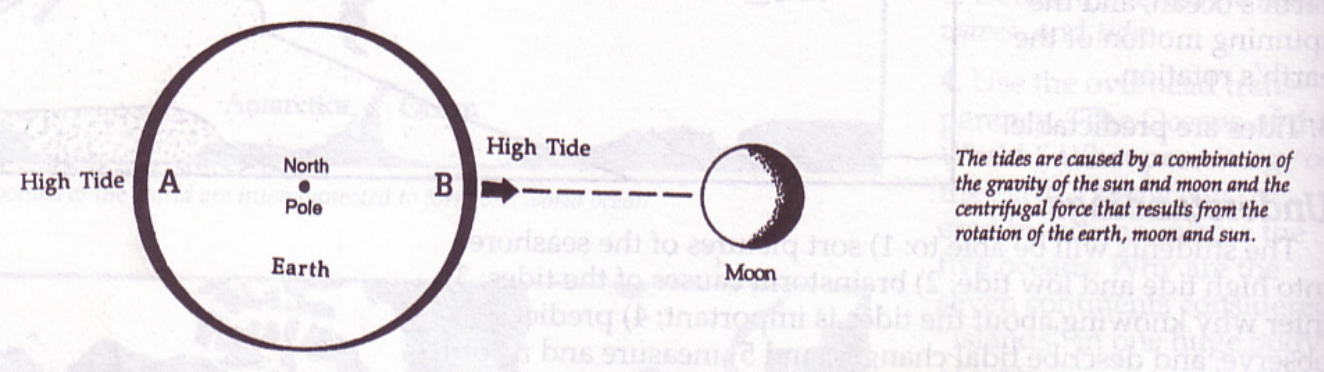
4. How many hours are between the high tide and the low tide?

5. Which is the lower tide, a -1.1 tide or a 1.1 tide?

6. How long does it take for the moon to go around the earth?

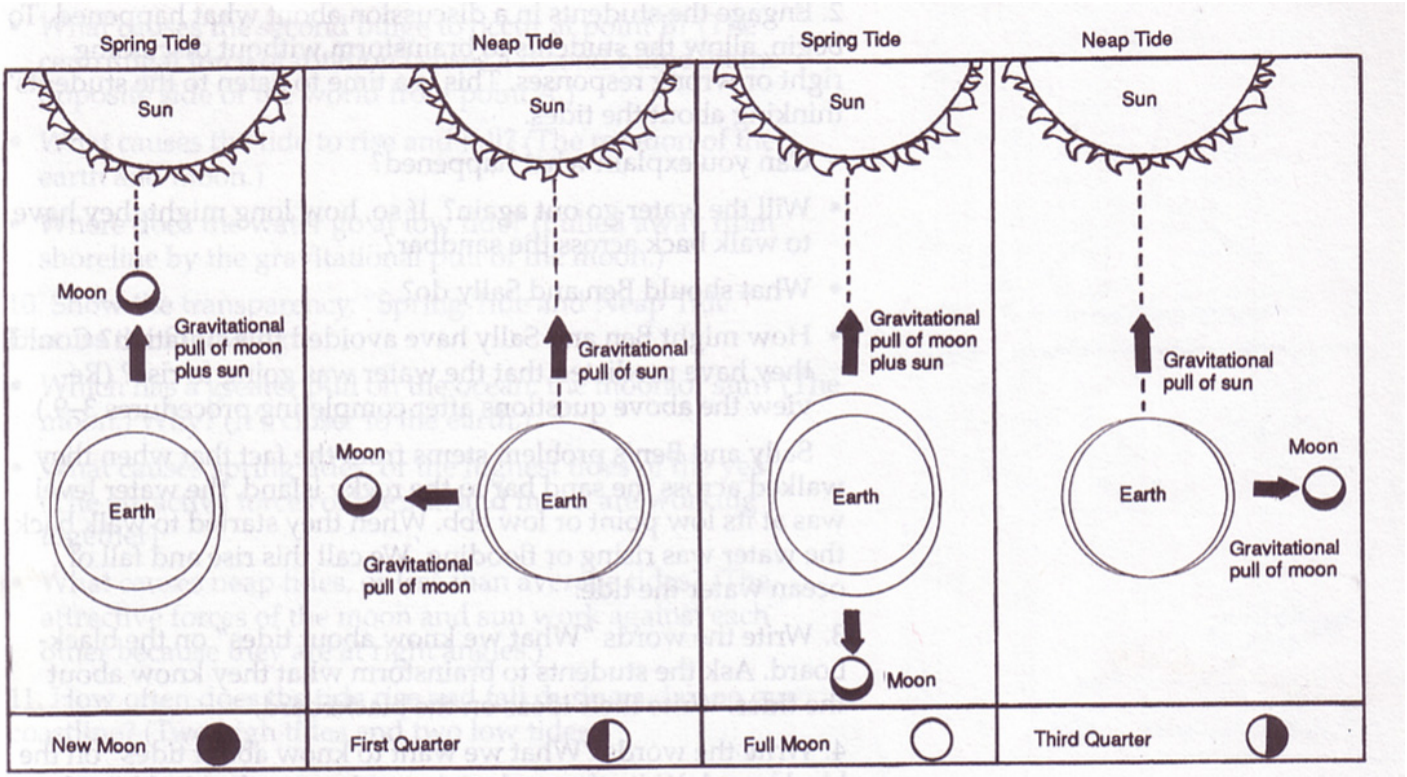
7. During the full moon and the new moon, the sun and moon pull extra hard and cause a very high, high tide and a very low, low tide. This is called a _____ tide.

Figure 1



The tides are caused by a combination of the gravity of the sun and moon and the centrifugal force that results from the rotation of the earth, moon and sun.

Figure 2



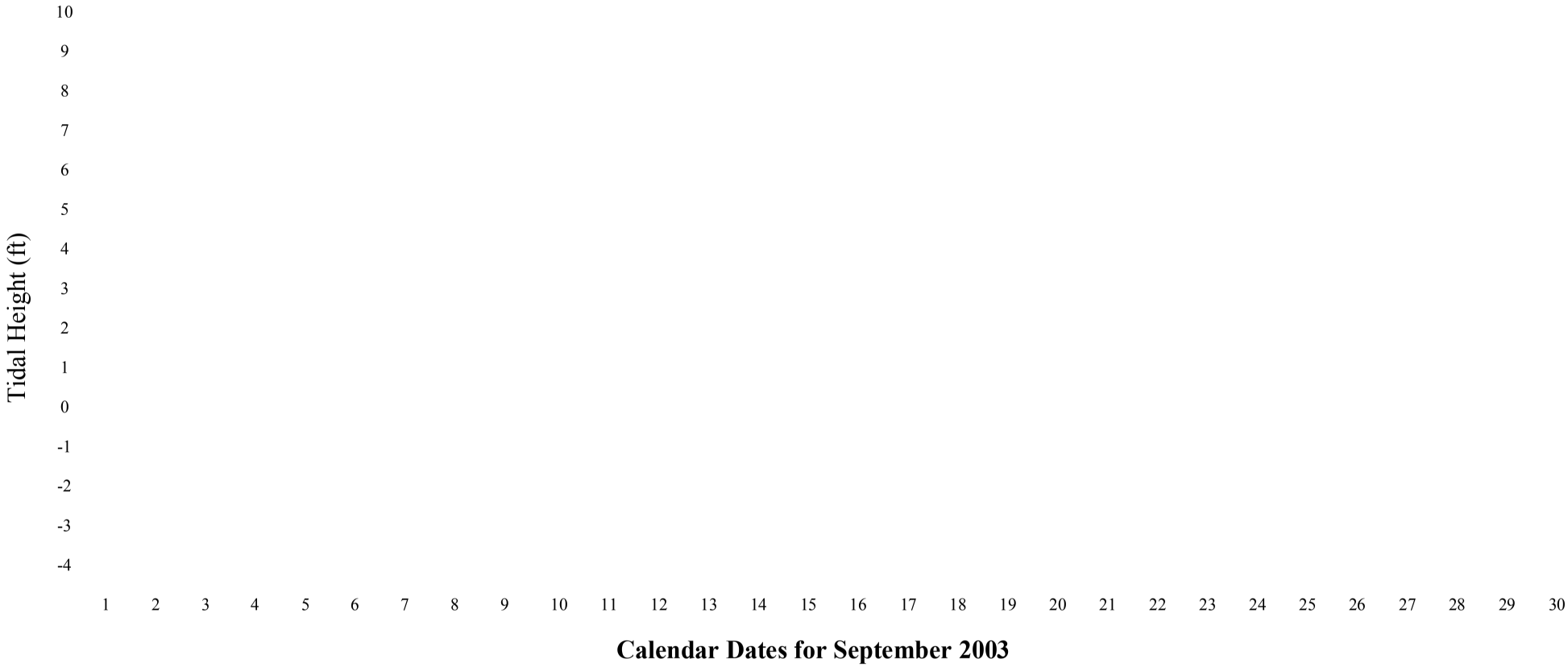
The tidal bulges are largest, and therefore the tidal range is greatest, when the moon and sun are in line and acting together. This happens at new and full moon. When the moon and sun are pulling in different directions, which occurs when the moon is in quarter, the bulges and tidal range are smallest.

The **Tide Graph** is on the next page.

Name _____ Date _____

_____

Tide Graph



What is an Estuary?

Subject Areas
Ecology, Language Arts

Objectives
Students will develop…
1. an understanding of what an estuary is,
2. knowledge of why an estuary is important, and
3. knowledge that estuaries changes because of natural processes and human use.

Materials
Essay: *Estuaries: Where Freshwater Meets Saltwater*

Comprehension Questions

Estuary Diagrams from www.southsloughestuary.org

Duration
45 minutes
(can be assigned as homework)

Overview
Students read an essay and complete the comprehension worksheet that follows.

Background Information
Estuaries are an important environment between the land and the sea. It is the place where the waters of all rivers and streams eventually drain into the ocean. Estuaries are shallow basins of water that we commonly call bays, sloughs, or inlets. An estuary is a semi-enclosed body of water where fresh water from rivers and streams mixes with salty water from the sea.

Estuaries are habitat for clams, oysters, other shellfish, and many species of fish. They provide feeding grounds and shelter from the open ocean and predators. Estuaries also serve as a nursery or rearing place for juvenile salmon, Pacific herring, shrimp, Dungeness crabs, and many other species.

The combination of organic nutrients, sunlight, and water in an estuary produces abundant microorganisms at the bottom of the food chain (plankton and algae), which are in turn food for many others.

Within the estuary, the following communities can be found:

Uplands are essentially coastal forests lying above the reach of the highest tides. The area is defined by the ridgelines of mountains, and the rivers and creeks create what is known as a watershed.

Salt Marshes are low-lying, near flat marine wetlands that form a unique habitat for wildlife. They can be huge, with hectares of grasses dominating, resembling a pasture.

A **Mud or Tidal Flat** mixes mud with sands, gravels, and varying amounts of water. Mud flats form in the most protected bays where fine sediments are able to settle. There are very few hard surfaces for attachment and the problems of movement, food gathering, and breathing are great. Thus, animals live either near the surface or in tubes or shallow burrows.

An **Eelgrass Bed** is basically a protected sandy beach where eelgrass stabilizes the bottom sediment. They provide food, shelter, and attachment sites for a community of interacting plants and animals.

Early settlers found lots of readily available food and building materials near estuaries. The rivers provided transportation to ship out logs from inland forests. River mouths made ports for foreign trade and ports for commercial fishing. The surrounding wetlands became centers of agriculture. Land use can affect an estuary through water running off the land and ending up in the river, then the estuary and finally the sea.

(The following was excerpted from *The Ecology of the South Slough Estuary: Site Profile of the South Slough National Estuarine Research Reserve*) The South Slough watershed is a 19,600 acre sub-basin of the Coos watershed drainage system and encompasses a diversity of habitat components including: (a) a drowned river-mouth estuary with open water channels, tidal flats, and salt marshes, (b) a mixture of palustrine and forested freshwater wetlands, streams, and riparian areas, and (c) coastal Sitka spruce and western hemlock forests with mixed-age stands of coniferous and deciduous trees and lush understory vegetation. (Excerpted from *The Ecology of the South Slough Estuary: Site Profile of the South Slough National Estuarine Research Reserve*)

Procedure

1. Prepare copies of the essay for each child.
2. Ask the students to read the essay and complete the accompanying comprehension worksheet.
3. Upon completion, lead a discussion to elicit understanding and correct any misinformation.

** You may wish to begin with a KKL chart whereby students list "What We Know" about estuaries, "What We Want to Learn" about estuaries, and at the completion of the unit "What We Learned". Students can add to the chart as you progress through the unit.

Assessment

Students should be able to correctly answer the comprehension questions provided.

Modifications

1. Students can team up to read the essay.
2. Students can answer the questions orally.

Estuaries:
Where Fresh Water Meets Salt Water

When a river flows into a bay of the ocean or when sea levels rise to flood a river's channel, estuaries form. Estuaries are places were the fresh water of rivers mixes with the salt water of the oceans.

Estuary areas are very important to many forms of aquatic life. The nutrients washed in by the rivers provide a fertile environment for both plant and animal life. Organisms living in the area do, however, require some special adaptations for survival. When the river brings in extra water, such as during periods of flooding, the salinity, or the amount of salt, in the water of the bay will be reduced. On the other hand, if drought causes the flow of fresh water to diminish, then the salinity of the bay may be increased. This means that the plants and animals of the estuary areas must be able to adapt to the changes in salinity or migrate out of the area.

The Coos River system drains into Coos Bay on the west coast of the United States. This is one of the largest estuaries on the western coast of the United States. The sediments that are washed into Coos Bay have formed more than a half a million acres of marshland. These marshes are made up of wetland grasses that slow the flow of water and trap sediments. The plants absorb nutrients. They grow well until the winter freezes. Then they die back and their leaves and stems break down into small particles called detritus. The shallow waters of the bay also support beds of rooted aquatic plants that break down into detritus.

The sunlight and the fertile waters also support phytoplankton that are the microscopic, floating plants of the sea. The phytoplankton and detritus form the base of the estuaries food chain. Zooplankton, the microscopic animal life of the sea, feeds on the detritus and phytoplankton. The zooplankton is fed upon by small fish and filter feeders such as oysters and clams. Larger fish, birds, and mammals feed on the smaller animals, and thus, a food chain forms.

Although hundreds of species of fish have been found to live in the bay, only about 20 species of them are able to live there year-round. Shiner perch and Staghorn sculpin are typically the most abundant resident fish in South Slough. Shiner perch occur in greatest numbers in spring and early summer, and their numbers decline in the fall becoming virtually absent in winter. Staghorn sculpins also follow a seasonal pattern, although they increase steadily in number over the spring and reach their peak abundance

in late summer. Their numbers decline in late fall and are virtual absent in winter as well.

Other species (like walleye surfperch, topsmelt, baby pipefish, threespine stickleback, and starry flounder) migrate in and out, depending on the time of year and the salinity of the water. Species richness of fish communities in the tidal channels is typically highest during September and October when surface salinities are about 15-20 psu at low tide. Rainfall events in November mark the beginning of the winter season which is characterized by more freshwater input, decreased salinity, and increased current velocities. Storms generally bring a gradual decline in the species of resident fish. Salmon species, however, migrate upstream through the rivers and streams of South Slough during periods of heavy rainfall and freshwater discharge in November-December (winter run) and May (spring run).

Estuaries are some of the most important areas of the ocean. They are nurseries where millions of ocean creatures begin their lives. They are fertile feeding grounds for vertebrates and invertebrates. The communities of plant and animal life have developed ways to cope with the changing salinity of the water. They are fragile communities, however, and haven't been able to adapt to some of the changes caused by people.

Dams on rivers have reduced the amount of water flowing into the estuaries, allowing salt water to flow into the areas that used to be mostly fresh water. Dams have also slowed or stopped the migration of fish into rivers for their annual spawning runs. Another problem is that streams and rivers are often seen as easy places to dispose of waste products. Pollutants that have been dumped into rivers have killed complete communities of plants and animals.

People want to be part of the food chain of the estuary by harvesting oysters, clams, crabs, and fish. Food is plentiful in a healthy estuary. Since only a few species are normally found in an estuary year-round, these species can build up to incredibly large numbers. Man, as a part of the food chain, benefits from a plentiful harvest, so protecting and preserving the health of the estuary should be of primary importance.

Name: _____ Date: _____

1. What is an estuary? _____

2. Would salinity increase or decrease in an estuary during spring floods? _____

3. What are phytoplankton and zooplankton? _____

4. What fish species is most abundant in South Slough? _____

5. Describe the seasonal variations of one of the fish species. In other words, how does the species population density change with the seasons? _____

5. Why are estuaries important? _____

6. What are three ways that man can affect the estuary? _____

Mystery Water

Subject Areas
Ecology, Chemistry

Objectives
Students will develop…
1. skills in classifying solutions by density.
2. skills in making inferences.
3. an understanding of estuaries and mixing of salt and fresh water.

Materials
Clear straws (cut part of them into 2 inch pieces – leave 1 whole for each group)

Modeling clay

Food coloring

Pipettes or medical droppers

Cups

Kosher salt (regular salt works – but Kosher works better)

Tray to put the clay on to hold the straw pieces (clean meat trays work well)

Duration
45 minutes
(can be assigned as homework)

Overview
In this activity students explore density (weight per unit volume or weight for the same amount) of several different salt solutions. The solutions model the changes in salinity that occur as freshwater streams enter the salty ocean.

Background Information
The proportion of salt to water in the ocean ranges from 33 to 38 parts per thousand. The proportion of salt in the fresh water rivers is less than 1 part per thousand. As the two meet, mixing occurs resulting in an increase in the concentration of salt as the river moves toward the sea.

The mixing of salt and fresh water is complicated by the fact that fresh water is lighter than salt water and tends to flow over it. Therefore, in addition to the presence of a salinity gradient from one end of the estuary to the other, much less salt is dissolved in surface water than in bottom water.

Because of the tidal movements of sea water, the salinity of estuarine water constantly changes. The salinity at a particular location increases twice daily with the incoming tides and decreases twice daily with the outgoing tides. Such tidal effects may be found up the river as far as 50 km from the mouth of the river.

The concentration of salt in the water is critical in the distribution of estuarine plants and animals. Salinity tolerances restrict many fresh water organisms to upper reaches of the estuary whereas many marine organisms are restricted by salinity requirements to the lower reaches of near the ocean. There are also organisms that are found only in the fluctuating environment of the estuary, because of the unique conditions caused by the varying salinity.

Procedure

To help your students understand the experiments they are to perform, do a sample demonstration to get them prepared. Make a saturated solution of cold water and salt (colored blue with a couple drops of food

coloring) and pour it in a baking dish. Then gently pour warm water (colored red) over the top of the cold water (the gentler the better the water will layer). Have your students make observations of the layering takes place. Explain that the blue water, which contains salt, is denser than the red water. (You may want to defer discussion of the effects of temperature on density until after they have completed their experiments.)

Prepare in advance a series of four solutions in 20 ounce plastic soda bottles ahead of time for the students' experiments.

1. In the first container marked R (for red), place 14.4 teaspoons (2.4 oz) of coarse salt and 20 oz of water. Use Kosher salt if possible. Add enough red food coloring to make a deep red solution.

2. In the second container marked G (for green) place 9.6 teaspoons (1.6 oz) of coarse salt to 20 oz of water. Add green food coloring.

3. In the third container marked place B (for blue) 4.8 teaspoons (.8 oz) of the coarse salt to 20 oz of water. Add blue food coloring.

4. In the fourth container marked C (for Clear) add no salt.

** These samples last forever and just a little is needed for the experiment.*

Share the following with your students:

A team of scientists collected a series of water samples from a freshwater stream, a tidal creek, the sound and the ocean. The team was interested in studying the salinity or saltiness of the water. On the way back to the laboratory, the labels came off the samples. Can you figure out which sample came from the stream, the tidal creek, the sound and the ocean? How could you experiment with these solutions to figure out which sample came from the sound?

One difference in the water samples is the density. Density is the weight per unit volume or weight for the same amount. The salty ocean water would be more dense than the fresh water because it has more salt.

Because the water samples are not clean, we will not taste them. One way we can investigate the density of these samples is to see which water samples mix and which samples layer one on top of the other. The most dense (have the greatest saltiness). Which water sample would be the least dense?

Food coloring has been added to help you see the different water

samples. By placing drips of the unknown solutions into clear drinking straws, we can see which layers mix and which layers do not easily mix.

Provide each set of students with 12 straw test tubes. Test tubes can be made by inserting a two-inch segment of clear straw into a flattened ball of florist clay. Provide each pair of students with four pipettes and a small labeled cup containing each of the unknown water samples. Each pair of students will need a copy of the diagram.

Instruct your students to predict which combinations of water samples will mix together and which will not mix and will stay separate. Mark those combinations that you think will stay separate. Mark those combinations that you think will not mix with a circle. Mark those that you think will mix together with an X. (The predictions will be more meaningful if students will predict and experiment one combination at a time?)

After students have had a chance to experiment, ask them to study their results and predict which sample came from the stream, the tidal creek, the sound and the ocean.

Assessment

Students should be able to complete the lab procedure and answer the questions on the worksheet.

Extensions

If you can take a coastal field trip, use a hydrometer to measure the density of water at various locations along the estuary and on the beach. Discuss how tides affect the salinity of the estuary.

Name: _____ Date: _____

Mystery Water Worksheet

Part 1: Predict

1. Predict which of the water samples will mix together and which of the water samples will layer.
2. Put a circle around those sample pairs that you think will layer.
3. Place an x on those samples that you think will mix.

Blue	Blue	Blue	Clear	Clear	Clear
Green	Red	Clear	Blue	Red	Green
Red	Red	Red	Green	Green	Green
Blue	Clear	Green	Blue	Clear	Red

Part 2: Experiment

1. Test each of the combinations of water samples to see which water sample is the most dense and which is the least dense. Add 10 drops of each colored water sample to the straw "test tube."
2. Draw a circle around those water samples that made layers.
3. Place an x on those samples that mixed together and did not layer.

Blue	Blue	Blue	Clear	Clear	Clear
Green	Red	Clear	Blue	Red	Green
Red	Red	Red	Green	Green	Green
Blue	Clear	Green	Blue	Clear	Red

Part 3: Conclusion

1. Where would you expect to find the densest water?

2. How would the density of the marsh change if a heavy rain occurred?

3. If you had a boat that was less dense than water would you expect it to float or sink?
4. Is it easier to float in a freshwater pond or in the ocean? Why?

Elodea Lab

Subject Areas
Ecology, Life Science, Microscopes

Objectives
Students will develop…
1. an understanding of what an estuary is,
2. knowledge of why an estuary is important, and
3. knowledge that estuaries changes because of natural processes and human use.

Materials
Per student or pair of students: 3 droppers, test tube of tap water, test tube of salt solution, 1 microscope slide, 1 cover slip, microscope, 1 paper towel, lens paper

Per class: Fresh Elodea in water, NaCl (sodium chloride or table salt), distilled water, 100-mL graduated cylinder, balance

Lab Worksheet

Duration
45 minutes
(can be assigned as homework)

Overview
Students will microscopically observe various cellular components and determine the effects of different salt solutions on Elodea plant cells.

Background Information

** You may wish to teach a lesson on basic cellular structure prior to this activity.*

In this lesson, students will microscopically detect the presence of chloroplasts, cell walls, and cell membranes of the common aquarium plant, Elodea. Students will then determine the effects of salt water on the Elodea plant cell structures.

By adding salt water to the Elodea cell environment, students will observe the process of osmosis, shrinkage of the cell contents due to water loss. However, you should not focus on terminology, but rather what happens during osmosis.

Procedure
** To make a 10% salt solution, weigh 10 grams of NaCl and place in graduated cylinder. Bring volume up to 100 ml with distilled water.*

** Elodea is a non-native plant. It should not be released into the environment. Discard in a trash can when no longer needed.*

Pre-lab
Distribute copies of the student sheet. Demonstrate how to make a wet mount slide and review the use of the microscope.

Lab
Encourage students to make careful sketches of their observations using colored pencils and to attempt to label as many structures as they can identify. The students will likely need help in identifying suitable regions of the Elodea to observe. You can prepare a typical slide and project it to help students do this.

Post-lab

The post-laboratory discussion should center on the students' explanations of the changes observed in the Elodea cells. Discuss what happens to the cell wall as the salt water is added. Students should have been able to distinguish between the cell walls and the cell membrane more clearly as more water leaves the cell and the cytoplasm shrinks.

Ask students the following questions to guide the post-lab discussion. As students answer the questions, sketch an Elodea plant cell on the board, filling in the cell with the cellular structures being discussed.

- What color were the Elodea cells? *(They were colorless except for green bodies.)*
- What were the green bodies inside the Elodea cells? *(Chloroplasts.)*
- Where were these green bodies mostly located? *(They were mostly located at the edges of the cell.)*
- Describe the shape of these chloroplasts. *(Ovals.)*
- Why are these chloroplasts green? *(They are green because of the presence of chlorophyll, the light-absorbing pigment necessary for photosynthesis.)*
- Were the chloroplasts stationary or moving around the cell? *(They should have been moving.)*
- Why were the chloroplasts moving around? *(The cytoplasm within the cell is constantly moving, thereby moving the various subcellular structures within the cell as well. This is known as cytoplasmic streaming.)*
- Did anyone notice a large space inside the cell?
- What is this large space? *(The central vacuole.)*
- What is the function of the central vacuole? *(The central vacuole is an organelle in plant cells that stores nutrients and water for the cell. It can take in and release water depending on the cell's needs. Animal cells do not have a central vacuole; they have many small vacuoles, which contain proteins, carbohydrates, water, and nutrients.)*
- Describe what happened to the Elodea cells in the presence of salt water. *(You should draw Elodea in salt water on the board.)*
- Why did the cells shrink? *(Salt caused the diffusion of water from within the cell to outside the cell.)*
- Why didn't the salt from the outside just move inside the cell instead of the water moving out of the cell? What does this tell you about the cell membrane? *(The cell membrane is selectively permeable. It allows the movement of water but not salt.)*
- What structure did the shrinking of the cell allow you to observe? *(The cell wall.)*
- Why didn't the cell wall shrink? *(It is rigid and provides support*

to the Elodea plant cell. Also, it allows salt to go through so it does not shrink, unlike the cell membrane.)

- From your observations, is Elodea a freshwater or saltwater plant?
- Why will a freshwater plant die if placed in saltwater?

Assessment

Ask students to use what they have observed to answer the following questions:

- Elodea normally lives in fresh water. What changes would you observe in the cells of an Elodea plant that was suddenly moved from fresh water to salt water? Why? How would osmosis affect the entire plant? *(Osmosis would occur because the high concentration of salt outside the cells would cause the diffusion of water from within the cell to outside the cells. This would result in the entire plant becoming very flaccid.)*

- If you wish to restore flabby, wilted green vegetables or carrot sticks to crispy "freshness," would you soak them in salt water or in plain water? Explain your answer. *(Vegetables should be soaked in plain water. Because of the high concentration of water outside the cells, water will flow into the cells. As the cells and central vacuole fill up with water, cells will become rigid.)*

Have students answer the questions of the worksheet. These questions can be used as an assessment tool to check student understanding.

Name: _____ Date: _____

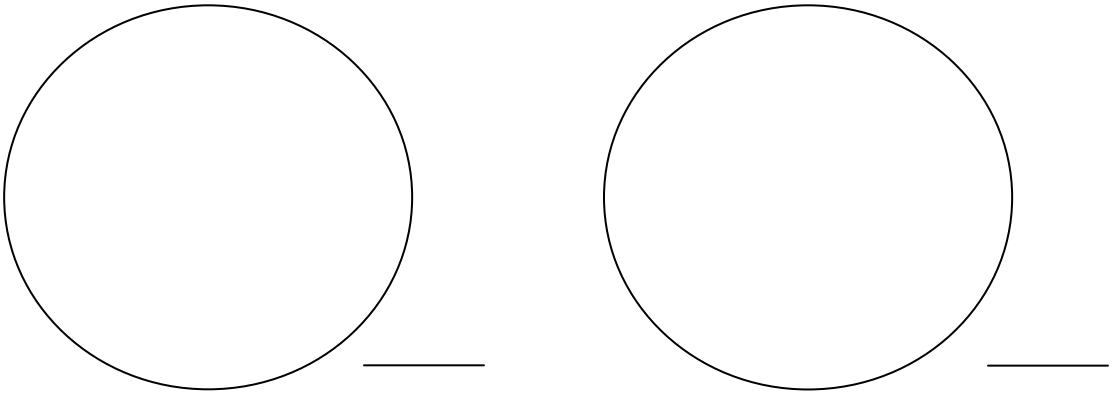
_____

Elodea Lab
How does saltwater affect freshwater plants?

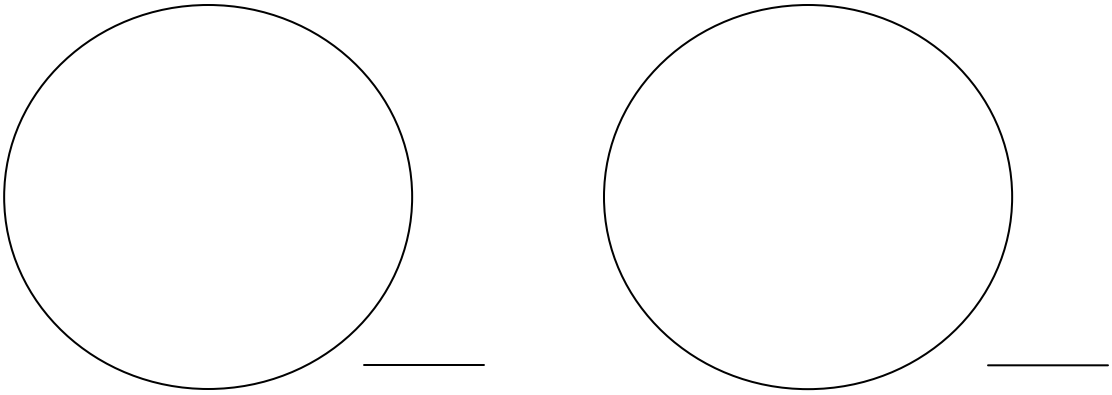
Objective: You will observe osmosis in plant cells.

Procedure:

1. Make a wet slide using an elodea leaf and water.
2. Observe leaf under LOW, MEDIUM, and HIGH powers. Draw what you see under medium and high powers only. Label cell wall, cytoplasm, and chloroplasts. Color the chloroplasts green. Try to locate the cell membrane, nucleus, and vacuoles.



3. Add saltwater as demonstrated previously. Label the parts as in step 2 above.



Conclusion:

1. How did the plant cells in pure water look different after the saltwater was added? _____

   _____

   _____

   _____

2. After the saltwater was added, was the water concentration higher inside or outside of the cell? _____

   _____

   _____

3. If the concentration of water is higher inside the leaf cell than on the outside of the cell, which way does most of the water flow? _____

   _____

   _____

   _____

4. When water flows from an area of high concentration to an area of low concentration, this type of diffusion is known as _____ ___.

5. Why will a freshwater plant die if placed in saltwater? _____

_____

_____

_____

_____

6. Before the invention of refridgeration some types of foods were preserved by adding large amounts of salt to them. How can adding salt preserve food? _____

_____

_____

_____

Who Lives Here?

Subject Areas
Ecology, Life Science, Language Arts

Objectives:
Students will:
1. identify characteristic life forms in an estuary;
2. match appropriate organisms to specific estuarine ecosystems; and
3. generalize that each ecosystem has characteristic organisms, adapted to live there.

Materials:
Access to website: www.southsloughestuary.org

Posterboard

Crayons, paints, markers

Magazine photos for posters

Index cards for 50 cards

Duration:
Two 45 minute sessions

Overview
Students will research particular ecosystems to discover characteristic organisms and then play an identification game using posters and cards.

Background Information
Each environment is suitable to those organisms that have adapted to its climate, soils, water, vegetation, other life forms, and to other ecological factors over a number of years. Plants and animals tolerant of heat and little moisture are adapted to life in the desert; clams and other shellfish to the tidal influxes of the mud flats.

Procedure
1. Divide the class into two equal groups. Explain that each group will make a game for the other. The object of the game will be to match animals to the estuarine ecosystem in which they live.
2. Ask each half of the class to choose three ecosystem they would like to know more about; for example, upland forest, freshwater wetland, salt marsh, tidal flats, eel grass beds, open water. Divide each half of the class into the three groups, one per ecosystem. Have each group research their ecosystem, learning its characteristic life forms including adaptations of the plants and animals that enable them to survive there.
3. Ask each group to make a poster showing the characteristic vegetation, terrain, etc. Posters of each ecosystem can be made from whatever materials the students choose.
4. For each ecosystem, students should make five cards, one per each five species of plants or animals found in that ecosystem. Students should include a description of the organism adaptations to its environment on one side of the card and a coding number on the other side, so that the organism described can be identified later. Do not write the name of the organism on the card.

5. When the posters and cards are complete, students in each half of the class should make a master list of the three ecosystems and animals their cards represent. Next, shuffle all their cards into one pile.
6. Each half of the class then exchanges posters and cards with the other half and then tries as a group to decide to which ecosystem each card belongs.
7. After each group has made their decision, hand each group the corresponding master list. One student per group can read off the organisms that correspond with each ecosystem.
8. Lead a class discussion using the following questions as a guide.
    - Has each organisms been placed in its proper ecosystem? If not, why?
    - Were there any plants or animals found in more than one ecosystem?
    - How can some organisms live in more than one ecosystem and others?
    - What are similarities and differences between the ecosystems and the characteristic life forms?
    - What are some of the most interesting adaptations?

Assessment

1. Pick any three organisms. Describe the estuarine community in which each organism lives, including identification of its habitat requirements.
2. Describe the importance of adaptation in animals.

Extensions

1. Look for threatened or endangered species in each ecosystem.
2. Compare and contrast additional ecosystems and life forms from a variety of places around the world. For example, compare the life forms of salt marshes to those of mangrove forests.

Web of Life

Subject Areas

Ecology, Language Arts, Visual Arts

Objectives

Students will develop…

1. collect information about various organisms in the estuary
2. create a mural that depicts the interdependence of various organisms with other components in the ecosystem, and
3. create a simulated web of life using a ball of string

Materials

Large cardboard (or heavy paper) to construct a 1.2m x 2.4m (4 ’x 8’) mural

Tape, glue

Ball of string or yarn

Access to website: www.southsloughestuary.org

Other reference materials

Duration

Two 50 minute periods

Overview

In this activity, students will take discover how the plants and animals of the estuary are connected to each other.

Background Information

Estuary plants and animals are connected is through a web of eating relationships. One primary function of an estuary, like any other ecosystem, is to produce and distribute energy. All life depends on the ability of green plants to use sunlight to synthesize simple sugars from carbon dioxide and water. This process is called **photosynthesis**. Plant eaters, or herbivores, eat the plants directly; meat eaters, carnivores, in turn eat both plants and animals. A **food chain** is a simplified way of showing energy relationships between plants and animals in an ecosystem. For example, sun → salt grass → vole → owl. However, rarely does an animal eat only one type of food. A food web describes the interconnection of the food chains in an ecosystem and provides a better picture of how plants and animals in an ecosystem are related to one another.

In this activity, students will create a “web of life” to depict the relationships among members of an estuary ecosystem. This web includes eating relationships (as in a food web), but also shows the various other kinds of relationships found in an estuary (shelter, reproduction). The web of life suggests that all living things are connected to all others, no matter how unrelated they may seem.

Procedure

(Modified from Project Learning Tree activity #45 Web of Life)

1. Ask students to work in pairs to brainstorm all the components they think they would need to make a healthy estuary. Invite them to share their ideas with the class.
2. Make a class list of animals that live in the estuary. Some examples are Pileated woodpecker, Great blue heron, kingfisher, Glaucous-winged gull, Snowy Egret, Raccoon, Vole, Harbour seal, limpets, ribbon worms, oysters, clams, snails, sea star, mud shrimp, ghost shrimp, Dungeness crab, shore crab, grasshopper and other insects, trout, salmon, sculpin, rockfish, and Bay pipefish.

3. Make a class list of plants that live in the estuary. Some examples are eelgrass, pickleweed, yarrow, sea lettuce, sea plantain, arrow grass, salt grass, and foxtail barley.
4. Divide the class into teams of two to four students. Ask each team to select one estuary organism to study. Make certain that the groups select a variety of plants and animals.
5. Instruct groups to collect as much information as possible about their chosen organism. * *You may choose to use the facts collected in the "Who Lives Here?" activity.*

Web of Life Mural

1. Ask groups to find or draw pictures of their plant or animal. Using these pictures, ask the class to create an estuary mural on large pieces of cardboard or heavy paper. * *You may wish to use the posters that were created in the "Who Lives Here?" activity.* The mural should also show important elements like sun, water, soil, and atmosphere.
2. When the mural is complete, introduce the web of life concept (see background information).
3. Place a push pin next to each organism. Then use yarn to connect each animal to other plants and animals with which it directly or indirectly interacts. Students can help by acting as experts on the species they researched. The completed mural forms a web of life for the estuary.
4. Discuss these questions:
   - What would happen if one element of the ecosystem were missing? (You can demonstrate by removing a push pin.)
   - What will happen to the other organisms?
   - What important elements are not included in our web?

All Tied Up (Variation)

1. After the students have completed their research, have the teams make a name tag for their chosen plant or animal. Ask one person from each group to sit on the floor in a circle.
2. Starting with one plant, ask that student to hold the end of a ball of string. Ask the team that studied the first plant to name another organism in the circle with which that plant interacts (for example, is eaten by or depends on). Pass the ball of string to this second student. This process will continue until each organism is linked to the ecosystem, and the ball is returned to the first student.
3. Ask students to pick one organism that seems less important than the others, and have it drop out. Ask if any other organisms should drop out because they depended on that organism. After one or more have dropped out, ask the students again to identify an organism that seems less important and repeat the procedure. Continue for a few more rounds, then ask the following questions:

- What happens when we remove a link in the estuary ecosystem? (Organisms that depend on it are affected.)
- Were the changes more dramatic when the system was composed of many parts or when it had fewer parts? (fewer)
- What can we say about the relationship between how many parts the system has (its complexity or diversity) and how stable it is? (In general, complexity makes it more stable.)

Assessment

Have teams demonstrate (by writing, drawing, or role playing) a web of life in which humans play a critical role.

Extensions

Make food web mobiles.

Upland Forests

Subject Areas
Ecology, Fine Art

Objectives
Students will be able to identify structural adaptations of animals that live in an upland forest.

Materials
Pictures of forests

Small plastic containers

Variety of modeling materials (pine cones, sand, glue, driftwood, paint, brushes, etc.)

Reference materials

Duration
Part One – 30 minutes
Part Two – 90 minutes (or can be completed at home)

Overview
Students discuss physical conditions of the upland forest and the adaptations of animals that live there. Students then create a 3-dimensional model in a small 16 oz. plastic container.

Background Information
One of four natural communities of the estuary, the **uplands** are essentially coastal forests lying above the reach of the highest tides. The area is defined by the ridgelines of mountains, and the rivers and creeks create what is known as a watershed.

A **watershed** is an area of land that drains to one body of water. The patterns and processes of watersheds are affected by the precipitation, climate, soil and geology, and by the life that depends on the water. Large watersheds have smaller watersheds nested within them. The 19,000 acres of South Slough watershed drain to the north to join with the Coos watershed near where it meets the Pacific Ocean. Like other watersheds on our coast, the South Slough watershed spans from the steep ridges that divide this watershed from other to its estuarine connection to the sea.

Upland plants slow the downhill flow of the rain water, allowing it to enter the soil. Now 'ground water', the rain saturate the soil and begins to slowly seep downhill between cracks and spaces in the soil. Plants return some of the ground water to the air before it gets very far along the watershed system.

Most of the differences people easily notice between different kinds of living things are really differences in how they adapt to where they live and to the other plants and animals in their community. Notice the leathery texture of the leaves of salal, evergreen huckleberry, and pacific wax mryrtle. Tough, smooth leaves let water drip off (discouraging mold) and hold water in the leaf (helping to keep the plant from drying out). Leathery leaves also make a less appealing meal for insects and other plant eaters.

Procedure
Part One - Discussion

1. Ask the students to collect pictures of coastal forests.
2. Ask the students to share their experiences. How many students have been to a coastal forest? Where was it located? What was it like to walk amongst the tall trees?
3. Ask students to brainstorm the physical characteristics of the forest. What are the hazards of living here? What are the benefits?
4. Ask students to brainstorm ways in which animals are adapted to live here.
5. How do you think the seasons affect the forest community?
6. Why is a forest called a "community"? (The organisms depend on one another for food, shelter, and survival.)

Part Two – 3 Dimensional Model

1. Cut a small window in the side of a small plastic container (margarine or sour cream tubs work best) approximately 4" x 3", leaving the top rim intact to secure the lid.
2. Ask students to create a 3-dimensional model of the forest inside the plastic container. They may use whatever materials they have available to them.
3. Display student models in the classroom with a large mural or map in the foreground. Models can be numbered with corresponding number on the map showing its actual location.

Assessment

Models should show at least 3 plants and 3 animals. Students should be able to describe (verbally or in written form) how each organism is adapted to live in its habitat.

Salt Marshes

Subject Areas
Ecology, Fine Arts

Objectives
Students will be able to identify structural adaptations of animals that live in a salt marsh.

Materials
Pictures of salt marshes

Small plastic containers

Variety of modeling materials (pine cones, sand, glue, driftwood, paint, brushes, etc.)

Reference materials

Duration
Part One – 30 minutes
Part Two – 90 minutes (or can be completed at home)

Overview
Students discuss physical conditions of tidal flats and the adaptations of animals that live there. Students then create a 3-dimensional model in a small 16 oz. plastic container.

Background Information
Salt Marshes are low-lying, near flat marine wetlands that form a unique habitat for wildlife. They can be huge, with hectares of grasses dominating, resembling a pasture.

Salt Marshes occur in temperate regions and are one of the most productive ecosystems on earth, producing up to two times as much plant food as the most fertile agricultural lands. The main producer for this important ecosystem is salt marsh grass which grows and actually thrives in the nutrient rich waters of estuaries where salt water from the ocean mixes with freshwater from land drainage.

A salt marsh is always producing new grass as old grass dies. Bacteria promote decay of the marsh grass which in turn produces detritus. Detritus is dead and decaying plant and animal matter. Fiddler crabs, snails, small shrimps, and some fishes feed on decomposed marsh grasses. Oysters and clams filter detritus and tiny living plants from the water. These detritus eaters serve as food for crabs, birds, and a variety of fish including salmon and trout. It is truly a nursery for dozens of life forms.

Countless numbers of birds are also dependent on salt marshes for food and nesting areas. Fish hawks, sandpipers and members of the heron family can be seen feeding along the marsh creeks during the spring and summer while ducks and marsh hawks are common sights in the winter months. Some birds, like red-winged blackbirds and terns, build nests and raise their young in salt marshes. Raccoons are common predators which feed on nearly everything.

The salt marsh environment is threatened by coastal development and pollution in many areas. The salt marshes, like other wetlands, seem likely areas for landfill and drainage as well as for other uses – yet they are important ecological systems.

Procedure
Part One - Discussion
7. Ask the students to collect pictures of salt marshes.

8. Ask the students to share their experiences. How many students have been to a salt marsh? Where was it located? What was it like to walk amongst the tall grasses?
9. Ask students to brainstorm the physical characteristics of the salt marsh. What are the hazards of living here? What are the benefits?
10. Ask students to brainstorm ways in which animals are adapted to live here.
11. How do you think the seasons affect the salt marsh community?
12. Why is a salt marsh called a "community"? (The organisms depend on one another for food, shelter, and survival.)

Part Two – 3 Dimensional Model

1. Cut a small window in the side of a small plastic container (margarine or sour cream tubs work best) approximately 4" x 3", leaving the top rim intact to secure the lid.
2. Ask students to create a 3-dimensional model of a salt marsh inside the plastic container. They may use whatever materials they have available to them.
3. Display student models in the classroom with a large mural or map in the foreground. Models can be numbered with corresponding number on the map showing its actual location.

Assessment

Models should show at least 3 plants and 3 animals. Students should be able to describe (verbally or in written form) how each organism is adapted to live in its habitat.

Tidal Flats

Subject Areas
Ecology, Fine Arts

Objectives
Students will be able to identify structural adaptations of animals that live in a tidal flat.

Materials
Pictures of tidal flats

Small plastic containers

Variety of modeling materials (pine cones, sand, glue, driftwood, paint, brushes, etc.)

Reference materials

Duration
Part One – 30 minutes
Part Two – 90 minutes (or can be completed at home)

Overview
Students discuss physical conditions of tidal flats and the adaptations of animals that live there. Students then create a 3-dimensional model in a small 16 oz. plastic container.

Background Information
A **Tidal Flat or Mudflat** mixes mud with sands, gravels, and varying amounts of water. Mud flats form in the most protected bays where fine sediments are able to settle. There are very few hard surfaces for attachment and the problems of movement, food gathering, and breathing are great. Thus, animals live either near the surface or in tubes or shallow burrows. Like most coastal seashores, they are subject to the rise and fall of the tides.

As the tide goes out, tidal flats may at first appear vacant of life. However, mud flat animals are just as abundant, they simply live underground and out of sight – at least while the tide is out. Tidal waters prevent mud flats from drying up. However, water temperatures fluctuate considerably during the tidal cycle. In the summer, the sun heats the mud flats during low tides. Cooler water is brought in with the incoming tides. In the winter, the reverse is true.

Mudflats support large populations of highly specialized animals, including many clams and snails, a few crustaceans, and many species of worms – evidenced by the little piles of sand and mud around openings to burrows, coiled fecal castings of worms, countless slime trails, and empty shells. The surface is abundant with many kinds of microscopic organisms (diatoms and many tiny crustaceans including amphipods and isopods). Also, mudflats often produce think planktonic blooms, which provide food for filter feeders.

The presence of tidal flats in the coastal environment is very important to shorebirds and wading birds. The invertebrates of the flats provide an abundant food source for shorebirds. Alternate feeding sites are available on nearby beaches for shorebirds when flats are completely flooded. Adjacent upland and transitional habitats provide areas for nesting and roosting.

Runoff from upland areas contributes fresh water, detritus, nutrients and sediment and may be a source of pollutants such as herbicides,

pesticides, fertilizers, industrial wastes and chemical spills. In urban areas, direct discharges of domestic and industrial wastes can constitute significant nutrient inputs into tidal flat systems. Salt marshes and eelgrass habitats contribute nutrients to tidal flats in the form of detritus and may provide a source of invertebrates to colonize tidal flats. The open bay interacts with tidal flats by providing water, nutrients, and invertebrates and by transporting nutrients and wastes away.

Procedure

Part One - Discussion

13. Ask the students to collect pictures of mudflats.
14. Ask the students to share their experiences. How many students have been to a mudflat? Where was it located? What was it like to walk in the mud? Why is it so difficult to walk in mud?
15. Where do mudflats occur? Locate them on a map of the Oregon coast. Why are they always located on a protected shoreline?
16. Ask students to brainstorm the physical characteristics of mudflats. What are the hazards of living here? What are the benefits?
17. Ask students to brainstorm ways in which animals are adapted to live here. (Many burrow beneath the surface. Others live on the surface.)
18. How do you think the seasons affect the mudflat community?
19. At low tide, what shore predators hunt for prey in mudflats? (Gulls, Great Blue Herons, crows, raccoons.)
20. Why is a mudflat called a "community"? (The organisms depend on one another for food, shelter, and survival.)

Part Two – 3-Dimensional Model

1. Cut a small window in the side of a small plastic container (margarine or sour cream tubs work best) approximately 4" x 3", leaving the top rim intact to secure the lid.
2. Ask students to create a 3-dimensional model of the mudflats inside the plastic container. They may use whatever materials they have available to them.
3. Display student models in the classroom with a large mural or map in the foreground. Models can be numbered with corresponding number on the map showing its actual location.

Assessment

Models should show at least 3 plants and 3 animals. Students should be able to describe (verbally or in written form) how each organism is adapted to live in its habitat.

Eelgrass Beds

Subject Areas
Ecology, Fine Arts

Objectives
Students will be able to identify structural adaptations of plants and animals that live in eelgrass beds.

Materials
Pictures of eelgrass beds

Small plastic containers

Variety of modeling materials (pine cones, sand, glue, driftwood, paint, brushes, etc.)

Reference materials

Duration
Part One – 30 minutes
Part Two – 90 minutes (or can be completed at home)

Overview
Students discuss physical conditions of eelgrass beds and the adaptations of the plants and animals that live there. Students then create a 3-dimensional model in a small 16 oz. plastic container.

Background Information
Sandy beaches in protected areas frequently become mixed with fine mud, and have a richer assortment of microscopic animals with a greater variety and number of larger inhabitants than exposed sandy beaches.

On some protected sandy beaches, eelgrass beds stabilize the bottom and prevent the sediments from being carried away. Eelgrass is a flowering plant adapted to relatively shallow water along the shore. The long, thin, bright green, grass-like blades are 50 cm or more in length. The thick root structures take hold in sandy bottoms and help stabilize the bottom sediments. The root structures and tangles blades provide food, shelter, and attachment sites for a community of interacting plants and animals.

The beds are rich in food supplies, such as diatoms, decaying plant and animal matter, and the eelgrass leaves themselves. Some of these organisms include amphipods, isopods, snails, nudibranchs, crabs, and fish. These animals, in turn, attract visiting predators to the beds during low tides.

Procedure
Part One - Discussion

21. Ask the students to collect pictures of different types of seashores.
22. Ask the students to share their experiences at these different seashores. How many students have been to a protected sandy beach? Where were these shores located?
23. Where do protected sandy beaches occur? Locate them on a map of the Oregon coast. Explain why these beaches are protected.
24. Ask students to brainstorm the physical characteristics of eelgrass beds. What are the hazards of living here? What are the benefits?
25. Using the picture that the students collected, look for examples of camouflage. (The green color and size of the isopods. A Dungeness crab buried in the sand with only its eyes protruding. A Sand Sole

changing color. A piepfish mimicking the eelgrass stems and frond)

26. Ask students to brainstorm other ways in which animals are adapted to live here.
27. Why is an eelgrass bed frequently called a nursery for seashore plants and animals? (The roots and leaves provide food and shelter for a great variety of juvenile snails, crustaceans, nudibranchs, and fishes.)
28. Why do so many animals live in an eelgrass bed? (The beds are rich in food supplies and provide protection from predators and from drying out at low tide.)
29. At low tide, what shore predators hunt for prey in an eelgrass bed? (Gulls, Great Blue Herons, crows, raccoons.)
30. Why is an eelgrass bed called a "community"? (The organisms depend on one another for food, shelter, and survival.)

Part Two – 3-Dimensional Model

4. Cut a small window in the side of a small plastic container (margarine or sour cream tubs work best) approximately 4" x 3", leaving the top rim intact to secure the lid.
5. Ask students to create a 3-dimensional model of an eelgrass bed inside the plastic container. They may use whatever materials they have available to them.
6. Display student models in the classroom with a large mural or map in the foreground. Models can be numbered with corresponding number on the map showing its actual location.

Assessment

Models should show at least 3 plants and 3 animals. Students should be able to describe (verbally or in written form) how each organism is adapted to live in its habitat.

Migration Danger

Subject Areas
Ecology, Social Studies (History, Geography)

Objectives
Students will be able to
1) Students will be able to operationally define migration; and
2) visualize the dependence of wetlands for migrating birds.

Materials
Sidewalk chalk or a stick

Playground or parking lot

Duration
One 30 minute sessions

Overview
In this physical activity, students role-play migrating birds and discover the importance of wetland habitat.

Background Information
Estuaries and other wetlands are an important ecosystem to insure the success of bird migration. Ponds, lakes and marshes provide food and shelter for traveling birds . Without the wetlands birds would not have the energy to make the trek from areas as far south as Panama. At the time of the European settlement of the United States there were 215 million acres of wetlands. Today there are less than 100 million. In addition to providing habitats for birds, wetlands also help relieve flooding, filter pollutants and are an integral part of the biosphere.

(The following was excerpted from *The Ecology of the South Slough Estuary: Site Profile of the South Slough National Estuarine Research Reserve*) The Coos estuary is an important resting, feeding area, and wintering ground for migratory birds of the Pacific flyway. About 250 species of birds are estuary resident inhabitants or migratory visitors to the area waters and shoreline of the Coos estuary. These include a variety of waterfowl (including American wigeon, black brant, pintail, bufflehead, scaup, western grebe, surf scoter), shorebirds (western sandpiper, least sandpiper, sanderling, black-bellied plover), seabirds (gulls, common murres, pigeon guillemot, brandt's cormorant, pelagic cormorant, brown pelican), and raptors (marsh hawk, osprey, bald eagle). American crow, belted kingfisher, and great blue heron are most commonly observed along the shoreline and in the exposed tide flats. (Excerpted from *The Ecology of the South Slough Estuary: Site Profile of the South Slough National Estuarine Research Reserve*)

Procedure
1. This activity will be best accomplished on a sandy section of the playground or a parking lot. The teacher will draw a large sized hopscotch course. The course can be drawn on the pavement with chalk or drawn on the sand/dirt with a stick The squares should be approximately 3'x3'. The hopscotch course should contain 10 squares.

2. Have the students line up at the beginning of the course. Tell the students that they are birds starting there journey northward. Tell the students that each of the squares represents a wetland between Alaska and Mexico. Students are then challenged to migrate northward on the course. They do not have to step on every square, however they must not go outside the course.

3. All students should be successful in the first migration. Now, tell the students you are a developer. You will destroy 2 wetland areas in order to build condos. Put an "X" on two of the squares. Tell students to make the migration once again. The students may not set foot on the destroyed wetlands. If they do, they die and thus may not participate in any further migrations. After all students have run through, destroy two more and repeat the procedure. Repeat this until all students fail to make the migration. Try to "X" off the squares in such a way that not all are destroyed but are so far apart students can not make the jump. This will help with the debriefing.

At the end of the activity ask students the following questions:

1. Explain why some birds died earlier than others?
2. Why did the rest of the birds die?
3. Explain how this game represents migration.
4. Why did the birds die even though some wetlands remained at the end of the game?
5. Why is it important to save wetlands?
6. How do migrating birds depend on wetlands during migration?

Extension

Have students investigate any developments in their community that threaten wetlands. Have students use field guides to investigate birds which migrate to and from their community.